APPENDIX G:

Standard Operating Procedures

Standard Operating Procedure
Boring/Well Installation

This protocol is designed to insure that proper techniques are used, safety is considered, and quality assurance maintained during soil boring and well installation.

DIGSAFE, municipalities and the owner are contacted prior to any soil boring or well installation to minimize chances of damaging underground utilities (DIGSAFE contacts utility companies to mark the location of utilities to the site). The Geologist or Inspector surveys the site visually for markings delineating the location of underground utilities. If warranted, the inspector modifies the drilling program to compensate for field conditions.

GEC personnel continuously monitors all drilling activities and is responsible for maintaining independent field notes, well logs and ensuring that proper procedures are followed.

Samples will be collected in ½, 1, 2, 3, or 5 foot sampling intervals depending on the goal of the sampling.

When samples are opened GEC will immediately collect a sample for headspace analysis. This sample is collected in a glass jar with an aluminum bladder below the lid. Sample will be warmed, if possible. Warming of the sample will typically take place inside the cab of vehicle. After warming for approximately 5-10 minutes the jar will be screened with the appropriate PID.

After collecting a headspace sample GEC will characterize soil, noting texture, color, moisture content, change in strata, any odors and the presence of staining or free product.

Samples will be collected according to a prescribed sampling plan or by field observation of obvious contamination.

All cuttings from drilling remain on the subject property and may be used as backfill in borings not completed as a monitoring wells. Or unless otherwise specified by a Soil Management Plan.

Monitoring well screens are set to depths adequate for the required sampling. In periods of high water table, well screens should extend one to two feet above groundwater. In periods of low water table, well screens should extend five to eight feet above groundwater. It is important to ensure that the screen is set above the seasonally high water table. Monitoring wells are typically constructed with a silica sand filter surrounding and extending to one to two feet above the screen. A solid PVC riser pipe extends from the top of the screen to ground level, has a one to two foot bentonite pellet seal above the screened interval and clean fill extending from the bentonite seal to within one food of ground surface. Above the clean fill is a cement seal and protective cover at the surface. No glues or solvents are employed in the well construction.

Soil Logs are to be maintained by the Geologist and should contain the following:

- Date and Location of boring/well
- Drilling contractor
- Job number
- Depth of sampling
- Boring number
- Depth to well point.
- Soil description includes; soil colors, grain size from greatest percentage to lowest, rock fragments, obvious fill constituents, staining, and odor if obvious.
- Changes in soil strata and elevation of the water table are also noted.

Standard Operating Procedure
Soil Sampling via Test Boring

Soil samples collected during the performance of test borings will, in most cases, either involve collection of "undisturbed" samples with an appropriate sampler or “grab” samples directly from the auger flights. Clearly, soil samples can be most easily recovered directly from the auger flights as the soil cuttings are brought to the surface, however, this technique does not provide an “undisturbed” sample and the actual depth from which the sample is collected is not known. The preferable method of sample collection for most purposes utilizes a GeoProbe or split barrel core (or split spoon) sampler. Either sampler can obtain samples of unconsolidated material from discrete depths with reasonable accuracy. Such samples may be referred to as “discrete interval” samples.

Note: The top few inches of either a GeoProbe or split spoon sample may include displaced material from above the sample interval,. Field personnel should be aware of this and exclude this portion of the sampler contents from the collected sample.

Auger Samples:

1. Samples are collected off the auger flight using the actual sample container or a clean instrument such as a spoon or spatula. Care must be taken when collecting the sample from the augers to avoid material, which is obviously not from the sampling horizon of interest (i.e. pavement in soil zones which are definitely not fill). Standard Operating Procedures which may be specific to the sample containers and the intended purpose of the sample (i.e. chemical analyses, PID screening) should be followed. Collect at least one sample in a clean 8 oz. glass jar (half filled) for PID screening and should be sealed and treated in an appropriate manner. Collect a second sample off the auger insuring that both samples are as close to identical in content samples as possible. This second sample should be used in describing the sediment characteristics.

2. Make a note of the appropriate depth of the augers in order to approximate depth of sample. With a sharp writing instrument, or permanent marker record the project number, boring number, sample number, estimated depth of sample and sample method (e.g. AUG for auger samples) on the top of the jar first jar. This jar should then be stored in a safe container (cooler or cardboard box) for later transport or set aside for PID screening.

3. Carefully examine the contents of the second jar to determine the lithology, i.e. the mineralogy, texture, sorting, moisture and color characteristics of the sediment sample. A complete and accurate description of the sediment sample should be recorded on the Test Boring Report, including the sediment characteristics, depth from which sample was recovered, collection method, and any notable features associated with the sample. Include the results of PID screening on the Test Boring Report.

4. Once a complete and accurate record of the sediment characteristics has been recorded on the Test Boring Report, the second soil sample may be discarded and the glass jar rinsed with water and dried. This glass jar may be reused to contain subsequent samples for sample characterization. Glass jars used for any purpose other than sediment description should not be reused.

Discrete Interval Samples:

Note: Discrete interval samples should be retrieved from the boring and/or opened only upon the direction of the GEC site rep. This is especially important for samples being collected for VOC analyses.

1. Upon retrieving the discrete interval sampler, examine the lower end or tip of the sampler; ensuring that any material collected in the tip of the sampler is not discarded. Examine the spoon to determine if any up-hole material was inadvertently collected in the sampler and remove these materials if possible. Using a clean spoon or spatula, prepare a head-space sample by half filling a clean 8 oz. “drillers” glass jar with three to five sub-samples which represent the spoon contents. Quickly cover the top of the jar with one or two sheets of clean aluminum foil and subsequently apply the screw cap to tightly seal the jar.

2. After opening the sampler and preparing a head-space sample, scrape away a path of material with a clean spoon, spatula or knife before examining the spoon contents for visually notable features (i.e. lithology, mineralogy, texture, sorting, packing, stratigraphic horizons, color changes, staining). In a field book accurately describe the soil sample in accordance with GEC's soil description and boring log protocol. Make note of visually notable features in field notes along with the boring number and sample depth.

3. With a sharp writing instrument, or permanent marker record the project number, boring number, sample number, estimated depth of sample, estimated recovery, and sample method (e.g. SS for split spoon) on the top of the jar first jar. This same information, as well as the depth of penetration, sample recovery and blow counts per six inches, should be recorded on the Test Boring Report. After describing the soil sample thoroughly, where necessary decontaminate the sampler to ensure that potential contaminants do not remain on the spoon prior to being reassembled and returned to the driller.

3. Soil descriptions should include such things as lithologic intervals, mineralogy, texture, sorting, and packing (if possible) characteristics of the sediment sample. A complete and accurate description of the sediment sample should be recorded on the Test Boring Report, including the sediment characteristics, depth from which sample was recovered, collection method, and any notable features associated with the sample.

4. Once a complete and accurate record of the sediment characteristics has been recorded on the Test Boring Report, the second soil may be discarded and the glass jar rinsed with water and dried. This glass jar may be reused to contain subsequent samples for sample characterization. Glass jars used for any purpose other than sediment description should not be reused.

Upon completion of test boring, samples should be packed in a cooler or cardboard box, or other appropriate container, for transport. Prior to transportation, care should be taken to insure that the glass jars are tightly sealed, to prevent spillage of contents, and that the jars will not be broken during the transportation. The box should be labeled on either of the end with the project number, location, date, boring numbers, and the name of the inspector.
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Standard Operating Procedure
Head Space Screening of Soil Samples
with a Photoionization Detector (PID)

Volatile organic compounds (VOCs) adsorbed to soil volatilize from the soil particles into the static headspace created within a container and the soil in direct proportion to the concentration of VOCs adsorbed to the soil. The concentration of VOCs in the headspace can be determined with a photoionization detector (PID), thus providing a relative indication of the concentration of VOCs in the soil.

Screening of soil samples for VOCs via the static headspace method involves seven steps, outlined below.

1) Collect two soil samples and place each in a separate, 8 ounce jar. One jar will be used as a duplicate for quality assurance purposes.

2) Place a layer of aluminum foil over the jar openings to form a seal. Screw the lids onto the jars, covering the aluminum foil.

3) Shake the jars for approximately 15 seconds and then allow the jar to equilibrate to room temperature (60^{o}C to 70^{o}C).

4) Prepare the PID for operation in accordance with the applicable standard operating procedure.

5) Remove the metal lid from the jar, puncture the aluminum foil and record the highest reading recorded by the PID.

6) Compare the results of the screening for the sample and the duplicate. A difference of up to 20% between the sample and duplicate is acceptable.

Depending on the situation and applicable criteria, the screening procedure outlined above may indicate that further analysis is warranted for a given sample. If so, collect soil samples in accordance with the applicable standard operating procedures.

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When samples are opened GEC will immediately collect a sample for headspace analysis. This sample is collected in a glass jar with an aluminum bladder below the lid. Sample will be warmed, if possible. Warming of the sample will typically take place inside the cab of vehicle. After warming for approximately 5-10 minutes the jar will be screened with the appropriate PID.

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- Depth to well point.
- Soil description includes; soil colors, grain size from greatest percentage to lowest, rock fragments, obvious fill constituents, staining, and odor if obvious.
- Changes in soil strata and elevation of the water table are also noted.

Standard Operating Procedure
Observation Well Sampling
Using a Low Flow Sampler

This protocol is designed to ensure that proper techniques are used, safety is considered, and quality assurance maintained during the performance of observation well sampling using low-flow techniques. A GEC representative is assigned to oversee and/or perform all observation well sampling for the project. The duties of the representative are to ensure that the scope of work is followed.

Sampling of groundwater observation wells using low-flow techniques is the primary means by which the chemical characteristics of groundwater can be determined in an accurate, representative, and repeatable manner. Therefore, it is imperative that care be taken in the development and subsequent sampling of observation wells.

Procedures for performance of groundwater observation well evacuation and sampling using low-flow techniques are outlined in the following paragraphs:

Well Evacuation and Sampling:

1) Prior to initiating any work the Health and Safety Plan, developed for the specific site activities, should be reviewed by all field personnel. The indicated measures on the Plan should be enacted prior to initiation of the sampling activities. Any concerns not addressed in the Plan are to be brought immediately to the attention of the Health and Safety Officer. Personnel participating in the sampling will dress with protective equipment appropriate for the anticipated conditions.

2) Decontaminate all equipment to be used in the performance of the activities in accordance with the protocol for decontamination. Decontamination should at least be performed by alternately rinsing all equipment with methanol and water and scrubbing the equipment with a paper towel.

3) To the extent that contamination may be known at a given site, observation wells should be sampled in an order from "least contaminated" to "most contaminated".

4) Test the well for accumulation of non-aqueous phase product (NAPL) using a pre-cleaned interface probe or transparent disposable bailer. If present, collect a sample of the NAPL and place in an appropriate sample container. This sample should be kept away from other samples.

5) Measure and record the depth to NAPL(if present) and depth to water. If NAPL is present, sampling for dissolved-phase contaminants should generally not be performed. In addition, if sampling is to be performed, appropriate measures should be taken to assure that any water removed from a contaminated well is disposed appropriately.

6) Historic measurements should be utilized to determine the total depths of wells. If a historic measurement is not available, total depth of the well should be gauged to determine the appropriate placement of the variable-speed low-flow sampling pump (pump). Gently lower the pump into the well to a point approximately half way between the top of the measured water elevation and the bottom of the well. If the water level in the well is situated above the top of the screened interval then the pump should be located half way between the top and the bottom of the screened interval. Tie the pump off at the appropriate depth to eliminate further disturbance of the water column.

7) Begin pumping the well at a rate no greater than 0.5 liters per minute (roughly 0.13 gallons or approximately two cups per minute). Provided there is ample room to measure depth to water after placement of the pump down the well, water levels should be monitored on a continuous basis. Drawdown of the water column should not exceed 0.1 meters. The pumping rate should be adjusted accordingly, based on water column drawdown. If the water level drops more than 0.1 meters, the pumping rate should be decreased.

8) Continuously monitor groundwater parameters including pH, temperature, specific conductance and dissolved oxygen (DO). In some situations it may also be appropriate to monitor turbidity. Record geochemical parameters at the onset of purging, five minutes into purging, and at roughly one-minute intervals thereafter.

In some cases longer intervals may be appropriate.

9) Purging should continue until geochemical parameters have stabilized. Stabilization shall be considered to have occurred when three consecutive measurements do not vary more than approximately 20% and visual and olfactory characteristics of the purged water do not change appreciably.

10) Record final geochemical parameters.

Well Sampling:

1) Samples at any given well will be collected in order of decreasing order of sensitivity to volatilization (i.e. VOC, total organic carbon, semi-volatile organics (BNA), ammonia, PCBs, pesticides, oil and grease, phenols, cyanide, sulfate and chloride, nitrate and ammonia, metals, and radionuclides)

2) Carefully fill sample containers directly from the pump discharge to the appropriately preserved, pre-labeled containers. Check that the sample containers seal properly and that the cap is sealed tightly. Record applicable information in the field logbook and complete all chain-of-custody documents.

Standard Operating Procedure
Sample Preservation and Chain of Custody

This protocol is designed to ensure that proper techniques are employed in the preservation and chain-of custody of samples collected for laboratory analyses or for screening. This Protocol is intended to be consistent with Massachusetts Publication #WSC-310-91 (Standard References for Monitoring Wells), and 40 CFR 136 (Guidelines Establishing Test Procedures for the Analysis of Pollutants).

The results of screening and/or laboratory analysis of solid, liquid or gaseous media constitute the basis of evaluation of the majority of the disposal sites under investigation. It is therefore imperative that the preservation of the samples be appropriate to the media being analyzed as well as the analysis which is being performed. In addition, the integrity of the sample is dependent upon the premise that a clear chain of responsibility for the sample integrity has been maintained. Without this "Chain-of-Custody", the integrity of the laboratory results may inevitably come into question.

The preservation and Chain-of-Custody (COC) protocols outlined in the following paragraphs are not intended to be all inclusive, and this protocol is written with the understanding that the sampling of certain media or analyses may require specific sample preservation. This protocol is, however, intended to cover the majority of the media and analyses performed as well as the COC procedures employed at the majority of waste disposal sites.

A COC program must be followed during sampling and handling activities from the field through laboratory operations. This program is designed to assure that each sample is accounted for at all times. Field data sheets, COC records, and sample labels must also be completed by the appropriate sampling and laboratory personnel for each sample. The objective of the sample custody identification and control system is to assure, to the extent practical, that:

- all samples are uniquely identified;
- the correct samples are analyzed for the correct parameters and are traceable through their records;
- important sample characteristics are preserved;
- samples are protected from damage or loss;
- any processing of samples (e.g., filtration, preservation) is documented; and
- client confidentially is maintained.

A sample is considered under a COC if it meets all of the following criteria:

- the sample is in your custody,
- the sample is in your view, after being in your possession,
- the sample is in your possession and then you locked it up to prevent tampering, and
- the sample is in a designated, secured area.

The following paragraphs outline GEC's preservation and COC protocol.

1) Prior to initiating any work, the Health and Safety Plan developed for the specific site activities, should be reviewed by all field personnel. The indicated measures on the Plan should be enacted prior to initiation of any sampling activities. Any concerns not addressed in the Plan are to be brought immediately to the attention of the Health and Safety Officer. Personnel participating in the excavations will dress with protective equipment appropriate for the anticipated conditions.

2) Sample integrity is assured by use of containers appropriate to both the matrix to be sampled and the analytes of interest. Sample containers must be prepared in the laboratory in a manner consistent with USEPA protocols. Unless the proper sample bottle preparation and sample preservation measures are taken in the field, sample composition can be altered by contamination, degradation, biological transformation, chemical interaction, and other factors during the time between sample collection and analysis. Prior to sampling GEC personnel will ensure that the sample containers obtained from either a laboratory or a commercial supplier have been prepared in accordance with DEP and EPA protocols. Sample containers are to be used once and discarded. Under no circumstance should a soil, water or

Standard Operating Procedure
Field Sampling Protocols
Quality Assurance/Quality Control

The purpose of the GEC QA/QC program is to generate analytical data that is of known and defensible quality. These procedures apply to all projects in which sampling is involved. QA/QC from one project is not transferable to another.

Decontamination

1) Decontamination should be performed on all reusable field sampling equipment and protective gear. Sampling equipment should be decontaminated before the collection of a sample and after sampling has been completed. Protective gear should be decontaminated after the collection of a sample.

2) It is necessary to use the following decontamination solutions in the field:

- Non-phosphate detergent plus tap water wash.
- Distilled/ deionized water rinse.
- 10% Nitric Acid rinse.*
- Methanol rinse, when sampling volatiles only.
- Acetone then hexane rinse.**
- Second distilled/ deionized water rinse. **

* Only if sample is to be analyzed for metals.
** Only if sample is to be analyzed for semi-volatile organics, PCBs or pesticides.

3) Sample bottles and sampling equipment should not be stored near gasoline, solvents, or other potential sources of contamination. If storage near gasoline, etc. is unavoidable, bottles and equipment should be sealed in containers or plastic.

4) Heavy equipment, including hand tools, should be cleaned by steam cleaning or manual scrubbing prior and subsequent to use in hazardous waste investigations.

Measures or Quality Control/Quality Assurance

1) Trip Blanks

- Trip blanks are used in order to detect additional sources of contamination that might affect analytical results. The following are potential sources of additional contamination:

  a. Sample containers,
  b. Contamination during shipment to and from the site,
  c. Ambient air contact with analytical instrumentation at the laboratory during analysis, or
  d. Laboratory reagent used in analytical procedures.

- One trip blank is required for every set of samples sent to the lab regardless of job size. Generally, the trip blank should be for VOCs. If, however, VOCs are not a parameter of the sampling round, consult the laboratory as to which parameter should have an associated trip blank.

- Trip blanks are to be kept with containers used in the sampling round at all times. More specifically, they should accompany the site-specific sampling containers from the time the containers leave the laboratory until they are returned for analysis.

- Obtain containers and trip blanks prepared specifically for each job from the laboratory. Return unused containers to the laboratory upon completion of a project.

2) Field Blanks

- Field blanks are used to indicate potential contamination contracted from ambient air or from sampling equipment. It also serves as a QA/QC for decontamination procedures.

- Collect one set of field blanks for every 20 samples per project. It is not necessary to take a field blank for jobs in which less than 10 samples are collected.

- Procedure

  a. Collect two sets of sample containers to cover all sampling parameters. One set will be full of analyte free water (obtain extra analyte free water to fill two VOA vials). The other set is empty.
  b. Go to the most contaminated area and run the water from the full containers, through the decontaminated sampling equipment and into the associated empty containers.
  c. Send to the lab for analysis.

- Use containers and field blanks prepared specifically for job.

3) Duplicate Samples

- Duplicate samples are collected in order to serve as a laboratory check. Therefore, it is important that the lab does not know which samples are to serve for this purpose.

- Frequency

  a. Obtain one (1) duplicate sample for every 10 samples of each matrix. If less than ten samples are collected of a given matrix, a duplicate must be collected anyway.
  b. If a total of less than 10 samples are collected, collect one (1) duplicate of the majority medium.
  c. If a total of less than five (5) samples are collected, it is not necessary to collect a duplicate sample.

* Note that the frequency as outlined here pertains to the number of samples collected per project, not per location of a given project.

- Procedures

The idea behind the duplicate sample is to collect two samples as close to identical as possible.

a. For Water:

Alternately fill containers for the same parameter with equal amounts of liquid per bailer. Fill duplicate VOC vials from the same bailer of liquid.

b. For Soil:

- VOC samples must be taken from the discreet sampling locations.
- For all other samples, mix the applicable soil in a decontaminated stainless steel or polyethylene bowl or tray. Then fill sample containers with the soil mix.
- When confronted with the option of collecting a water sample or a soil sample, choose the water sample.

- Labeling for the laboratory

  a. Label the containers normally and give the duplicate samples different reference numbers.
  b. Indicate the quantity of duplicates in the "special instructions" or "remarks" portion of the chain of custody and laboratory services sheet, however, do not indicate the reference numbers of the duplicates.
  c. Upon receipt of analytical results, contact the laboratory and convey all data pertaining to the duplicates for their QA/QC.

4) Background samples

- Background samples are taken only if it is required for comparison of site conditions to the surrounding environment. This is to be dictated by client needs on a site to site basis.

5) Performance Evaluation Samples

- The project manger should consider the use of the following performance evaluation samples on a periodic basis. Typically, these will be reserved for larger jobs:

  a. Laboratory performance evaluation samples

  - Collect duplicate samples and send to two different laboratories for comparison. Avoid using soil samples for this procedure.
  - Send a sample of known quantity and quality to the laboratory in order to determine laboratory performance. Such samples can be prepared by any laboratory.

  b. Gas chromatograph (GC) performance evaluation samples

  - Acquire a sample of known quantity and quality from a laboratory. Analyze the sample with the gas chromatograph in order to determine the integrity of GC results.

Field Sampling QA/QC

1) When sampling a well, collect VOA samples first and samples for other analytes last.

2) Start sampling at the presumed least contaminated areas, proceeding to the more contaminated areas.

3) Preservatives

- Consult the laboratory in order to determine which sampling parameters require preservatives. The laboratory will provide sampling containers specific for each job.
- It is necessary to fill the sample container when using preserved bottles; preservative is added with this assumption
- If samples are not collected correctly, they will not pass GEC QA/QC.

4) A chain-of-custody must accompany each set of samples from the job site to the laboratory. Be sure to identify the presence of trip blanks on the chain-of-custody sheets.

5) If possible, use the numbering system outlined on the attached sheet for identifying samples.

Ordering Sample Containers

1) Pre-plan sampling strategy to determine the sample parameters, the number of sample points including QA/QC samples, and the matrix of the given sample points.

2) Call laboratory and tell them:

   - Sample parameters,
   - Number of samples to be collected,
   - The number of container sets needed for trip blanks, field blanks, and duplicates, and
   - The matrix of each sample to be collected.

3) Sample containers should be ordered specifically for each job. Any sample containers unusedat the end of the job should be sent back to the laboratory.

Conclusions

1) Pre-planning is crucial.

2) Keep open communication with the laboratory on all matters.

3) If you make a mistake in sampling collection, accept it, and retake the necessary samples.

Standard Operating Procedure
Sampling with a Spade or Scoop

The simplest, most direct method of collecting soil samples for subsequent laboratory analysis, or field screening, is with the use of a spade and scoop. A normal lawn or garden spade is utilized to remove the top cover of soil to the required depth and then a smaller stainless steel scoop is used to collect the sample.

This method can be used in most soil types but is limited somewhat to sampling near the surface. Samples from depths greater than 0.5 meters become labor intensive in most soil types. Very accurate, representative samples can be collected using these procedures depending on the care and precision demonstrated by the technician. The use of a flat, pointed mason trowel to cut a block of the desired soil will be of aid when undisturbed profiles are required. A stainless scoop or lab spoon will suffice in most other applications. Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is particularly common with garden implements such as potting trowels.

Procedures:

1) Prior to initiating any work, the Health and Safety Plan developed for the specific site activities should be reviewed by the Field Technician. Any prerequisite activities identified by the Plan should be enacted prior to initiating of the sampling activities. Any concerns not addressed in the Health and Safety Plan document are to be brought immediately to the attention of the Health and Safety Officer.

2) Carefully remove the top layer of soil to the desired sample depth with a precleaned spade.

3) Using a precleaned stainless steel scoop or trowel, remove and discard a thin layer of soil from the area which comes in contact with the shovel.

4) Transfer sample into an appropriate sample bottle with a clean stainless steel lab spoon or equivalent.

5) Check that a Teflon liner is present in the cap of the sample container. Secure the cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach, supplemented by a minimal holding time. For specific containerization and preservation requirements consult the laboratory prior to sample collection.

6) Label the sample bottle with the appropriate sample tag. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Complete all chain-of-custody documents and record in the field logbook.

7) Decontaminate equipment after use and between sample locations.